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The Role Of Flexibility On Software Development Performance: An Empirical Study On Software Development Teams

Ayşe Günsel[a] , Atif Açikgöz[b] , Ayça Tükel[c], Emine Öğüt[d] a*

[a,b] *Kocaeli University, Kocaeli, 41380, Turkey*

[b] *Fatih University, İstanbul, 34000, Turkey*

[c] *Okan University, Istanbul, 34722, Turkey*

[d] Selcuk University, Konya, Turkey

Abstract

As both business and technological environments change at an increasing rate, flexibility has become a critical issue for project management in general and software development projects in particular. Even though previous research has examined the relationship between team flexibility and team performance, there still remains a gap in literature in respect to a software development project outputs. Accordingly in this paper, we examine the relationships among software team flexibility and software project outputs (market success, speed to market, and the functionality of the new software product) using survey data from 86 software development projects. The results reveal that the first dimension of software team flexibility, team autonomy, positively affected market success, speed to market, and software functionality, whereas the second dimension, team diversity, positively affected only speed to market and software functionality. Managerial and theoretical implications of the study are discussed.

Keywords: Team Flexibility; Team Autonomy; Team Diversity; Software Project Performance.

1. Introduction

Without a doubt, software development is a complex problem solving and decision making process that competed in a dynamic, fast-moving environment (Gallivan, 2003; Akgün et al., 2007). As both business and technological environments change at an accelerated pace, software teams' flexibility in responding to changes in system requirements has become one of the primary success factors in software development projects (Lee and Xia, 2007).

* *Corresponding author. Tel. + 90-262-303-1634 fax. +90-262-303-1535*

Email address: ayse.gunsel@kocaeli..edu.tr

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However little research has empirically examined software team flexibility in terms of its key dimensions and its effects on software project performance.

Software teams' flexibility is the primary focus of this paper. We examine it from several angles because it involves social and emotional interactions in response to environmental changes and complex problems in the delivery of information systems (Cooper and Sawaf, 1997). To reach this aim, this paper is arranged in four parts. Following this section, the main characteristics of software development process are discussed, and the features and the dimensions of team flexibility defined. Next, we describe the methodology applied to exploring the relationships among team flexibility and project outcomes. Using survey data from 86 software development team members, we test the relationships among the software team flexibility, emotional intelligence, and project outcomes. Finally, the conclusions are set out, along with some recommendations for future research..

2. Literature Review And Hypotheses

2.1. Software Development

Fast-changing business environments and revolutionary advancing information technologies make software development a challenge (Barki, et al., 2001). Software development projects involve both organizational and technical dimensions in rapidly changing business environments (Lee and Xia, 2005), so a software team's ability to sense and respond to changing business environments and system requirements is a critical issue in software development projects (Gefen and Ridings, 2002). However, many organizations have significant difficulty coping with rapid changes in general, and for software development projects in particular. For example, Koch (2006) reports only a few software development teams or units have the "ability to sense and respond to business and environmental changes." Team flexibility can help ensure success in such dynamic environments

2.2. Team Flexibility

Flexibility is defined as an individual's or an organization's ability to be proactive, adaptable, and resilient (Jones, 2005) and as the capacity to change and to adapt to challenging environments (Georgsdottir and Getz, 2004). In other words, flexibility is the ability to adjust both behaviors and structures as necessary to ensure survival, especially in the face of uncertainty (McComb et al., 2007).

Flexibility first appeared in the academic literature more than six decades ago. However, only in the last two decades has there been significant attention on flexibility. The primary reasons for the rise of this concept are the globalization of markets and the emphasis on quality and customization (Jones, 2005; Reed and Blunsdon, 1998: 458). All of these changes suggest an increased need for the capacity to respond to change. As a result, flexibility, as the ability to adapt to new, different, or changing requirements, has emerged as a competitive advantage and a requirement in many organizational activities, including automation, high technology maneuvers, manufacturing,58. P. Weill, The relationship between investment in information technology and firm performance: a study of the valve manufacturing sector. Information Systems Research **3** 4 (1992), pp. 307–333. View Record in Scopus | Cited By in Scopus (231) and IT (Byrd and Turner, 2001). Flexiblity can either be adaptive when challenges occur in the environment or spontaneous when the organization has a preference for change absent external pressure for change (Swezey and Salas, 1992; Georgsdottir and Getz, 2004; Lee and Xia, 2007).

Flexibility is considered to be a major part of the team processes construct (e.g., Hirokawa et al., 2000; McComb et al., 2007). At the team level, flexibility is defined as the collective ability of a work group or a team to respond effectively and efficiently and to adapt to business and technological changes (Li, 2010). The key here is to understand that team flexibility is the ability to adapt, not the ability to change. Change is permanent and slow, while adaptation is temporary and fast (Henkin, 2006). A software team's flexibility refers to its ability to respond to changing system requirements (Lee and Xia, 2005**).**

Management researchers have suggested many dimensions for flexibility. For instance, flexibility can be measured in terms of range, diversity, mobility, autonomy, or extent of organizational responses to environmental changes (Slack, 1983; Das and Elango, 1995; Sanchez, 1995; Volberda, 1996; Anand and Ward, 2004; Lee and Xia, 2007). Flexibility can also be evaluated in terms of time, cost, new capabilities, or the effort required for the organization to respond to environmental changes (Slack, 1983; Evans, 1991; Pindyck, 1991; Athey and Schmutzler, 1995; Das and

Elango, 1995; Sanchez, 1995; Volberda, 1996; Nelson and Ghods, 1998; Tan and Sia, 2006). Table 1 provides some examples of studies on flexibility with a diversity of dimensions.

Table 1. The Literature Related to the Dimensions of Team Flexibility

Dimensions	Literature Examples
Extent	Das and Elango, 1995
Mobility	Anand and Ward, (2004)
Range	Slack, 1983; Sanchez, 1995; Anand and Ward, (2004)
Diversity	Volberda, 1996; Evans, 1991; Lee and Xia, (2007)
Autonomy	Lee and Xia, (2007)
Effort	Nelson and Ghods (1998)
Time	Das and Elango, 1995; Evans, 1991; Nelson and Ghods, 1998; Volberda, 1996; Sanchez, 1995
Robustness	Tan and Sia (2006)
Modifiability	Tan and Sia (2006)
New Capability	Tan and Sia (2006)
Cost	Nelson and Ghods, 1998; Sanchez, 1995; Athey and Schmutzler, 1995
Difficulties	Das and Elango, 1995; Sanchez, 1995; Tan and Sia (2006); Young-Ybarra and Wiersama (1999)

Following the study of Lee and Xia (2007), we identify and examine two dimensions of software team flexibility: software team autonomy and software team diversity. Software team autonomy refers to the extent to which the team has the freedom to make its own project-related decisions and conduct its work the way its members deem fit without interference from senior managers outside the team (Gerwin and Moffat, 1997; Sethi, 2000). Team diversity refers to the composition of the team in terms of the backgrounds and functional expertise.

Several authors have drawn attention to how flexibility enables teams to see problems in new ways, to find creative solutions, and to redefine problems in order to find original solutions (e.g., Georgsdottir and Getz, 2004). For example, Griffin (1997) portrays flexibility as an important factor in many aspects of organizational management in general and important aspect of cross-functional team performance in particular. Imai et al. (1988) suggest that one of the strengths of Japanese product-development teams is their flexibility. Similarly, Lee and Xia (2005) consider team flexibility as *a* critical success factor for project success. Following the prior literature on new product development and software development, we use market success, speed to market, and the functionality of the new software product as the outputs of software development projects. Accordingly, our first and second hypothesis is as follows:

H1: Team flexibility, measured as a) team autonomy and b) team diversity, is positively related to the project outputs in the context of software development projects

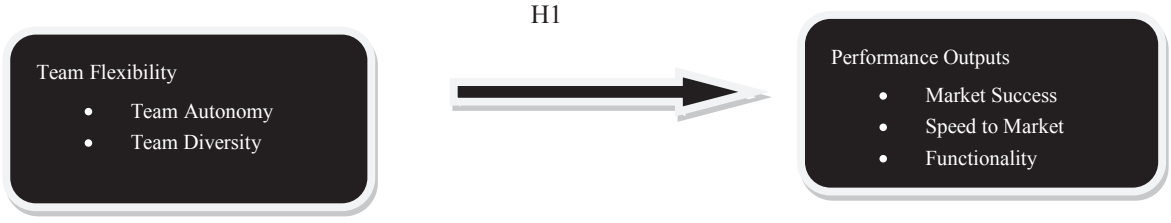

Figure 1. The study's model

3. Methodology

3.1. Measures

To test the hypotheses, we used multi-item scales adopted from prior studies for the measurement of constructs. Each construct was measured using 5-point Likert scales ranging from "strongly disagree" (1) to "strongly agree" (5). The Appendix lists our measures, but a brief summary of the measures follows.

To measure team flexibility we used five questions adapted from Lee and Xia's (2007) team flexibility scale. We asked two questions for autonomy and three questions for team diversity.

To measure the market performance of a new software product after launch, we asked eight questions concerning whether the product meets or exceeds managerial, profit, and market expectations. These items were adapted from Cooper and Kleinschmidt (1987). This operationalization is similar to Hackman's (1987) group performance operationalization: "meeting or exceeding the performance standards of the people who receive and/or review the team's output" (p. 323).

We asked five questions to measure speed to market, that is, the ability of a team to develop and launch a new software product rapidly (Kessler and Chakrabarti, 1999). Speed to market was assessed relative to pre-set schedules, to company standards, and to similar competitive projects.

To measure the functionality of the software product, we asked four questions adopted from Lee and Xia (2007).

3.2. Sample and Data Collection

After identifying the question items, we used the parallel-translation method: Items were first translated into Turkish by one person and then retranslated into English by a second person to ensure that the meanings of question items were correctly transformed from English to Turkish. The two translators then jointly reconciled all differences. The suitability of the Turkish version of the questionnaires was then pre-tested with five part-time graduate students working in the software industry who were involved in at least one software development project each. After refining the questionnaire based on interviews with the pre-test subjects, we distributed and collected the questionnaires using the "personally administrated questionnaire" method. The questionnaire items can be found in the Appendix.

Table 2. Characteristics of the study sample

	Frequency	**Percent**
Team size		
2-5	41	47.1
6-10	26	29.8
11-20	13	14.9
>21	7	8
Total	86	100
Duration of projects (months)		
Less than 3 months	11	12.8
4 -12	35	40.7
12-24	19	22.1
Over 24 months	21	24.4
Total	86	100
Respondent position		
Owner/president	4	4.70
Director general	3	3.50
Senior engineer/ Technical leader	15	17.40
Department manager	3	3.50
Product/project manger	5	5.80
Engineer/ Programmer	44	51.20
IS specialist/analyst	12	14.00
Total	86	100

The initial sample consisted of 200 software development firms in Istanbul that have affiliations with European and American firms. First, the firms' managers were contacted by telephone and the aim of the study explained. Of the 200 firms contacted, 71 agreed to work with this study. Of the 71 firms that agreed to participate, 36 firms completed our questionnaires by returning a total of 86 surveys. (Some firms participated in the research with more than one respondent.) Thus, usable data for our analysis consisted of 86 surveys. Table 2 demonstrates the characteristics of our sample.

3.3. Analyses and Results

We used the partial least squares (PLS-Graph 3.0, Chin, 2001) approach to path modeling to estimate the measurement and structural parameters in our structural equation model (SEM) (Chin, 1998). Following Kleijnen, Ruyter and Wetzels (2007), we used reflective indicators for all our constructs (see Appendix). To assess the psychometric properties of the measurement instruments, we estimated a null model with no structural relationships. We evaluated reliability by means of composite scale reliability (CR) and average variance extracted (AVE). For all measures, PLS-based CR is well above the cut-off value of .70, and AVE exceeds the .50 cut-off value. In addition, we evaluated convergent validity by inspecting the standardized loadings of the measures on their respective constructs and found that all measures exhibit standardized loadings that exceed .60. Next, we assessed the discriminant validity of the measures. As Fornell and Larcker (1981) suggested, the AVE for each construct was greater than the squared latent factor correlations between pairs of constructs (see Table 3).

Table 3. Correlations of latent variables

	Variables	1	2	3	4	5
1	Team autonomy	--				
2	Team diversity	,390(**)	--			
3	Project speed	,414(**)	,667(**)	--		
4	Market success	,367(**)	,543(**)	,440(**)	--	
5	Software functionality	,356(**)	,405(**)	,335(**)	,467(**)	--
	Mean	3,6105	3,232	3,3643	4,1337	3,8178
	Standard Dev.	0,77232	0,93138	0,82017	0,67921	0,7023

$^{*}q < .05$, $^{**}q < .01$

We used PLS path modeling, which allows for explicit estimation of latent variable (LV) scores, to estimate the main effects in our model (Figure 1). We used PLS Graph 3.0 and the bootstrapping resampling method to test their statistical significance. This procedure entailed generating 500 sub-samples of cases randomly selected, with replacement, from the original data. Path coefficients were then generated for each randomly selected subsample. T-statistics were calculated for all coefficients based on their stability across the subsamples in order to determine which links were statistically significant.

Table 4. The Results

Hypothesis	Relationship	Path coefficient (β)	Results
H1a	Team autonomy → Market success	.36***	*Supported*
	Team autonomy → Project speed	.31***	
	Team autonomy → Software functionality	.28***	
H1b	Team diversity → Market success	.15	*Partly Supported*
	Team diversity → Project speed	.20*	
	Team diversity → Software functionality	.35***	

Fit measures	Indogenous construct	Final model
R^2	Market success	.25
	Project speed	.34
	Software functionality	.42

Path coefficients are not standardized.

$^{*}p <.1$, $^{**}p < .05$, $^{***}p < .01$

As shown in Table 4, our hypotheses are largely confirmed. The results show that team autonomy is positively related to the market success ($\beta = .36$, $p < .01$), the speed ($\beta = .31$, $p < .01$), and the functionality ($\beta = .28$, $p < .01$) of new software products. Next, we found that, the second dimension team diversity is positively associated with the speed ($\beta = .20$, $p < .1$) and the functionality ($\beta = .35$, $p < .01$) of new software product. However the analysis provide

no empirical evidence in support of the relationship between team diversity and the market success of the new software products. So H1a is fully supported while H1b is partly supported

The team flexibility subdimensions, team autonomy and team diversity explain 21 percent of the variance (R2 = .21) in the market success of the software development project, 29 percent of the variance (R2 = .29) in market speed and 37 percent of the variance (R2 = .37) in the functionality of the new software product.

4. Discussion and Conclusion

The results of this paper reveal several findings that have important implications for both research and practice. First, the study explores the influences of team flexibility on the outputs of the software development process. The first dimension of team flexibility, that is, team autonomy, was found to have positive effects on market success, speed to market, and the functionality of the new software product, suggesting that the freedom of team members in playing their roles and performing their duties and responsibilities in software development projects results in better performance. The second dimension of team flexibility, team diversity, was also found to have significant influences on speed to market and the functionality of the new software product. This result suggests the synergy among team members may shorten the duration of project, allow deficiencies to be addressed quickly, and increase the functionality of the resulting software.

From this research, managers should enhance the flexibility of teams during the software development projects. From this perspective, managers should give autonomy to project team members to make important decisions about the software product; field the team with members from a variety of specialization areas, background cultures, and perspectives (cross-functionality); establish a psychologically safe environment in which team members are encouraged to use their experiences and proficiencies and to interact and collaborate freely with each other without fear of reprisal within the software development team can result in better performance.

In order to enhance the market success of the software products, develop them faster, and increase their functionality, management should enhance the flexibility of he project teams. Specifically, management should promote team autonomy, select experienced team members from many different specialization areas and proficiencies.

4.1.Limitations of the Study

The sample size was relatively small (n = 86), and the research used data obtained from a single informant for a given project. However, sinceTurkey is a developing country with an immature software industry, it was challenging to gain access to software development teams. Therefore, readers should be cautious in generalizing the results; a larger sample may provide a better representation of the population of software development teams.

The generalizability of the sample is another limitation of this study. The study was conducted in a specific national context, Turkey, so readers should be cautious in generalizing the results to different cultural contexts.

4.2.Conclusion

With the increasing pressure on rapid software development in a highly dynamic and competitive market, the question of what makes a software development projects successful has attracted many researchers and practitioners from a variety of fields. However, software development remains a poorly understood process within the field of organizational behavior. This study sought to determine the factors that promote the success of software development projects by investigating the influence of team flexibility on software development project outputs and found that team flexibility is positively associated with speed to market, market success, and the functionality of software products. Future researchers will find the areas of collaboration, cross-functionality, and co-development a rich source of questions for the software development literature.

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APPENDIX- Measures

Standardized loadings are in parantheses.
CR: composite reliability; AVE: average variance extracted.
* denotes the dropped item, either they reduce the AVE less then .50, or they have low loading wieghts.

Team flexibility: adopted from Lee and Xia (2007)
Team Autonomy
Items measuring team autonomy:

The project team was allowed to freely choose tools and technologies.(.92)
The project team had control over what they were supposed to accomplish. (.69)
CR = .79
AVE = .66

Team Diversity
Items measuring team diversity
The members of the project team had skills that complemented each other (.85)
The members of the project team had a diversity of different experiences (.88)
The members of the project team varied in functional backgrounds (.54)

CR = .81
AVE = .60
Market success of software products (Adapted from Cooper and Kleinschmidt,1987).
Our product (software):
Met or exceeded volume expectations (.80)
Met or exceeded the first year number expected to be produced and commercialized (.86)
Met or exceeded overall sales expectations (.81)
Met or exceeded profit expectations (.88)
Met or exceeded return on investment expectations (.90)
Met or exceeded senior management expectations (.85)
Met or exceeded market share expectations (.53)
Met or exceeded customer expectations (.81)
CR = .94
AVE = .66

Speed-to-market (Adapted from Kessler and Chakrabarti,1999)
This product (software):
Was developed and launched faster than we expected (.77)
Was developed and launched (fielded) faster than the major competitor for a similar product (.76)
Was completed in less time than what was considered normal and customary for our industry (.84)
Was launched on or ahead of the original schedule developed at initial project go-ahead (.80)
Top management was pleased with the time it took us from specs to full commercialization (.85)
CR = .90
AVE = .65

Software Functionality: adopted from Lee and Xia (2007)
The software delivered by the project achieved its functional goals (.82)
The software delivered by the project met end-user requirements (.77)
The capabilities of the software fit end-user needs (.86)
The software met technical requirements (.79)
CR = .88
AVE = .66